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Final Technical Report
Covering the Period April 1, 1993 - March 31, 1995

NASA-Ames Grant #NCC 2-785

ADVANCED AUTOMATED COMPUTER SYSTEM METHODOLOGIES

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FINAL TECHNICAL REPORT

NASA-AMES COOPERATIVE AGREEMENT NO. NCC 2-785

ADVANCED AUTOMATED COMPUTER SYSTEM METHODOLOGIES

For the period April 1, 1993 - March 31, 1995

The objective of this proposal, "Advanced Automated Computer System Methodologies", were to define, develop, and evaluate advanced concepts and methodologies in areas of computer science, with emphasis on technologies involving knowledge-based systems and advanced computer architectures focused on potential NASA aerospace applications of automation and robotics.

Achievements have included the following areas:

1. Computer Integrated Documentation.
2. Technology assessment.
3. Ground Processing Scheduling System software .
4. Computer graphics.
5. Interactive multimedia.
6. Cataloging system for image database.
7. Inverse modeling and in time series analysis.
8. Emergency flight control computer methodology.
9. Air Traffic Control Tower testbed.

The following paragraphs expand on each of these areas.

1. COMPUTER INTEGRATED DOCUMENTATION

Contextual knowledge acquisition for the Computer Integrated Documentation project was made more user friendly through hyper text media. Methods were developed for the indexing and retrieving of information used by the system for learning, and for text processing and representation in the hyper text format of documents.

2. TECHNOLOGY ASSESSMENT

Technical input and review was provided to aid in the development of Information Sciences Division strategic plans and aeronautics research plans. Arrangements and coordination were provided for the semi-annual ATAC general meeting held at Kennedy Space Center in March, 1993. ATAC Report #16 was published and

submitted to the U.S. Congress in June, 1993. ATAC technology recommendations were formulated and presented to the space station redesign team in April, 1993.

3. GROUND PROCESSING SCHEDULING SYSTEM SOFTWARE

Assisted in the documentation of the Ground Processing Scheduling System software which is being used at Kennedy Space Center for the automated scheduling of ground launch processing of the Space Shuttle vehicle. Conducted an invited tutorial on advanced automated scheduling techniques and presented a research paper on reactive scheduling to the International Joint Conference on Artificial Intelligence in Chambery, France.

4. COMPUTER GRAPHICS

Integrated and established computer color graphics capabilities within Information Sciences Division. Designed and developed series of charts and graphs for Human Exploration Demonstration Project. Created 3-D models of the Mars Rover and photorealistic renderings of simulated planetary terrain and working environment for remote operation. Modeled human-powered centrifuge and 3-D animation of Habitat Chamber for physiological system monitoring. Designed and developed series of charts and graphs for demonstration of ARC Information Systems in NASA Headquarters.

5. INTERACTIVE MULTIMEDIA

Implemented innovative methods of interactive multimedia for Integrated Data System analysis. Integrated hardware and software for interactive presentations with random access linking text and graphics databases.

Participated in interface design for interactive learning tools within K-12 program (On-Line Academy).

6. CATALOGING SYSTEM FOR IMAGE DATABASE

Developed new cataloging system for storing and organizing image database. It will provide fast access by division staff to extensive library of graphics, 3-D models and video clips created within this year.

7. INVERSE MODELING AND IN TIME SERIES ANALYSIS

Implemented several experimental cases in the area of parametric design to prove that GDMI (Goal Directed Model Inversion, an algorithm designed to generalize supervised learning) can easily be applied to solve problems such as detection of planets in a binary star system and the torque generated by engine parts. Worked on inverse kinematics problem for a robotic arm to reach a goal while avoiding an obstacle.

Worked in the area of Time Series Analysis. Given data in terms of flux over a long time period, the data was analyzed using the neural network cascade correlation algorithm to classify the signals given in terms of flux to determine the passage of a planet in a star system.

8. EMERGENCY FLIGHT CONTROL COMPUTER METHODOLOGY

Investigated advanced automation concepts to complement and enhance conventional aircraft flight control. Performed research and development analytical testing in preparation for a series of piloted simulations which were conducted on the Advanced Concepts Flight Simulator (two engine generic civil transport) at Ames Research Center to develop and evaluate advanced automated flight control laws to allow the pilot to satisfactorily land a civil transport when all flight control surfaces have failed.

Developed advanced automated flight control laws to provide longitudinal and lateral-directional control of a civil transport utilizing only engine thrust. Utilized a concept called PCA (Propulsion Controlled Aircraft, in which the pilot controls the aircraft attitude and heading by controlling engine thrust through manipulation of the conventional autopilot cockpit controls) in simulation tests in August, 1994 (new PCA capabilities to be tested and evaluated in April of 1995).

The advanced control laws are an initial step in the investigation of neural networks to identify aircraft response in an unexpected flight condition resulting from various flight system failures. Neural networks have the advantage of identifying input-output relationships without requiring a specific dynamic model. Initially, engines of the ACFS simulated aircraft will be used as the first "training system" for neural networks.

9. AIR TRAFFIC CONTROL TOWER TESTBED

Prepared architectural design of Air Traffic Control Tower testbed facility including conceptual design and functional requirements. Integrated hardware and software for interactive real-time visual system simulating airport environment. Designed projection system configuration for ATC Tower Simulator.

PUBLICATIONS

Advanced Automation in Robotics for the Space Station and for the United States Economy, Progress Report No. 16, June, 1993.

PRINCIPAL INVESTIGATORS

The Principal Investigator for Foothill DeAnza Community College was Phyllis Yasuda. Co-Investigator for NASA-Ames were Marlene Chin and Sonie Lau.